

Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems

Quarterly Technical Progress Report

October 1, 2003 – December 31, 2003

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ABSTRACT

This document summarizes progress on Cooperative Agreement DE-FC26-01NT41185, “Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems,” during the time-period October 1, 2003 through December 31, 2003. The objective of this project is to demonstrate at pilot scale the use of solid honeycomb catalysts to promote the oxidation of elemental mercury in the flue gas from coal combustion. The project is being funded by the U.S. DOE National Energy Technology Laboratory under Cooperative Agreement DE-FC26-01NT41185. EPRI, Great River Energy (GRE), and City Public Service (CPS) of San Antonio are project co-funders. URS Group is the prime contractor.

The mercury control process under development uses catalyst materials applied to honeycomb substrates to promote the oxidation of elemental mercury in the flue gas from coal-fired power plants that have wet lime or limestone flue gas desulfurization (FGD) systems. Oxidized mercury is removed in the wet FGD absorbers and co-precipitates with the byproducts from the FGD system. The current project is testing previously identified catalyst materials at a larger, pilot scale and in a commercial form, to provide engineering data for future full-scale designs. The pilot-scale tests will continue for approximately 14 months at each of two sites to provide longer-term catalyst life data.

This is the ninth full reporting period for the subject Cooperative Agreement. During this period, project efforts included continued operation of the first pilot unit at the GRE Coal Creek site with all four catalysts in service and sonic horns installed for on-line catalyst cleaning. During the quarter, two catalyst activity measurement trips were completed, and catalyst pressure drop was closely monitored with the sonic horns in operation. For the second pilot unit at CPS’ Spruce Plant, CPS completed a scheduled unit outage on Spruce Plant during October, so no source of flue gas was available for catalyst pilot unit operation until the end of the month. In early November, the third and fourth of the catalysts to be tested in the pilot unit were installed. The pilot unit was started up with all four of the catalysts in place on November 13, and initial catalyst activity results were measured in December. Mercury SCEM relative accuracy tests were also conducted during the catalyst activity measurement period in December. This technical progress report details available results from these efforts at both sites.

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INTRODUCTION

This document is the quarterly Technical Progress Report for the project “Pilot Testing of Mercury Oxidation Catalysts for Upstream of Wet FGD Systems,” for the time-period October 1, 2003 through December 31, 2003. The objective of this project is to demonstrate at pilot scale the use of solid honeycomb catalysts to promote the oxidation of elemental mercury in the flue gas from coal combustion. The project is being funded by the U.S. DOE National Energy Technology Laboratory under Cooperative Agreement DE-FC26-01NT41185. EPRI, Great River Energy (GRE) and City Public Service (CPS) of San Antonio are project co-funders. URS Group is the prime contractor.

The mercury control process under development uses catalyst materials applied to honeycomb substrates to promote the oxidation of elemental mercury in the flue gas from coal-fired power plants that have wet lime or limestone flue gas desulfurization (FGD) systems. The oxidizing species are already present in the flue gas, and may include chlorine, hydrochloric acid (HCl) and/or other species. Oxidized mercury is removed in the wet FGD absorbers and co-precipitates with the byproducts from the FGD system. The objective of this project is to test previously identified effective catalyst materials at a larger scale and in a commercial form to provide engineering data for future full-scale designs. The pilot-scale tests will continue for approximately 14 months at each of two sites to provide longer-term catalyst life data. After successful completion of the project, it is expected that sufficient full-scale test data will be available to design and implement demonstration-scale or commercial-scale installations of the catalytic mercury oxidation technology.

The two utility team members are providing co-funding, technical input, and host sites for testing. GRE is providing the first test site at their Coal Creek Station (CCS), which fires a North Dakota lignite, and CPS is providing the second site at their J.K. Spruce Plant, which fires a Powder River Basin (PRB) subbituminous coal. These two host sites each have existing wet FGD systems downstream of high-efficiency particulate control devices, an ESP at CCS and a reverse-gas fabric filter (baghouse) at Spruce.

The remainder of this report is divided into five sections: an Executive Summary followed by a section that describes Experimental procedures, then sections for Results and Discussion, Conclusions, and References.

EXECUTIVE SUMMARY

Summary of Progress

The current reporting period, October 1, 2003 through December 31, 2003, is the ninth full technical progress reporting period for the project. Efforts over the current period included continued operation of the first mercury oxidation catalyst pilot unit at the CCS site with all four catalysts installed and sonic horns in operation for on-line catalyst cleaning, and initial operation with the third and fourth catalysts installed in the second pilot unit at CPS' Spruce plant.

The pilot unit at CCS is installed at the outlet of an induced draft fan and downstream of the cold-side electrostatic precipitator on Unit 1. An SCR catalyst and a palladium-based catalyst (Pd #1) have been in operation since October 3, 2002. A subbituminous ash-based catalyst, SBA #5, was installed in the pilot unit the first week in December 2003. The fourth, Carbon #6 (C #6) catalyst was installed and placed in service on June 5, 2003. During the current quarter, two sets of catalyst activity measurements were made at the CCS site, and the pilot unit was monitored from off site to observe catalyst pressure drop values.

After seven months of operation with sonic horns in service for on-line catalyst cleaning, they appear to be effective in limiting fly ash buildup in the horizontal gas flow catalysts for three of the four catalysts. At the end of the current quarter, the pressure drop across the C #6 catalyst remains at about 0.4 in. H₂O (2000 acfm flue gas flow rate) and the pressure drop across the SCR catalyst (1500 acfm) is about 0.2 in. H₂O. For the Pd #1 catalyst, the pressure drop signal is very noisy, most likely due to buildup of condensed water in the tubing to the pressure drop transducer in the cold weather. The last day the measurement appeared to be valid (11/5) the pressure drop was about 0.35 in. H₂O. For the fourth catalyst, SBA #5, the pressure drop continues to increase with time, and was up to about 4 in. H₂O by the end of the quarter. This suggests that the sonic energy level is not sufficient to prevent fly ash buildup across this catalyst, or it may be a result of damage to the catalyst substrate from the current levels of sonic energy.

Catalyst activity measurement trip were conducted in October and December, and showed greater than 85% Hg⁰ oxidation for the C #6 catalyst, about 75% oxidation for the Pd #1 but significantly lower activity (<50% oxidation) for the SCR and SBA #5 catalysts, as measured with a mercury SCCEM. In the October measurements, both of the lower performing catalyst showed continued improvements in activity since they were put back in service with the horns in operation in June. In December, the SCR catalyst showed a small, continued improvement, but the SBA #5 showed a loss of activity since October. This loss is most likely an effect of fly ash buildup and/or substrate damage, as evidenced by the pressure drop increase across this catalyst.

CPS' Spruce Plant was off line for a planned outage at the beginning of the quarter. The unit came back on line on October 27 as planned, but was up and down during the week because of startup issues. The installation of the third and fourth catalysts to be tested at Spruce and the restart of the catalyst pilot unit was delayed until the week of November 10, when station craft personnel were available to support the catalyst installation. The two catalysts were installed and the pilot unit was put back in operation on November 13. Initial catalyst activity results were

measured at Spruce in December. These measurements showed that the fabric filter outlet flue gas mercury content is still highly oxidized (~75% or greater). The resulting, low inlet elemental mercury concentrations to the pilot unit (about 1 $\mu\text{g}/\text{Nm}^3$) make it difficult to quantify catalyst oxidation activity. At an expected 90% oxidation across the catalysts, the outlet Hg^0 concentration should be only 0.1 $\mu\text{g}/\text{Nm}^3$, which is at or below the mercury SCEM detection limit. The baghouse is being rebagged in January, replacing the 11-year-old bags, which may reduce the mercury oxidation across the baghouse. An advantage of having a baghouse rather than an ESP upstream of the catalyst pilot unit is that there has been no tendency for fly ash buildup in the catalyst chambers. No sonic horns have been installed on the pilot unit at Spruce.

Also during December, mercury SCEM relative accuracy tests using the Ontario Hydro method and other gas characterization tests were conducted at Spruce. The results from this December measurement trip are not yet available, and will be reported in the next quarterly report.

One subcontract was issued during the current reporting period, to Metco Environmental for conducting these gas measurements. The effort was subcontracted because URS source samplers were committed to other projects and were not available during the desired sampling period.

Problems Encountered

There were no significant new problems encountered during the reporting period, other than the technical issues described in Section 4 of this report and mentioned above.

Plans for Next Reporting Period

The next reporting period covers the time-period January 1 through March 31, 2004. The pilot unit at CCS will remain in operation with all four catalysts in service and sonic horns operating in each compartment to prevent fly ash buildup. Routine sampling trips will be conducted to evaluate catalyst activity at CCS. The original project schedule called for pilot unit operation to end after 14 months in service (~December 2003). However, the schedule has been extended because the C #6 catalyst has only been operation since June, and more operating time is needed to be able to predict its life. It is expected the pilot unit at CCS will operate through April 2004.

Operation of a second oxidation catalyst pilot unit, at CPS' Spruce Plant, will continue with all four catalysts installed. Routine sampling trips will be conducted to evaluate catalyst activity at Spruce. During the coming quarter, the baghouse on the host unit will be rebagged, and gas measurements will be made with the mercury SCEM to evaluate the impacts of the bag change on mercury oxidation at the catalyst pilot inlet.

Prospects for Future Progress

During the subsequent reporting period (April 1 through June 30, 2004), a final intensive flue gas sampling trip will occur at the end of the long-term catalyst evaluation period at CCS (late April 2004), after which the pilot unit will be shut down. At the second site, CPS' Spruce Plant, pilot unit operation should continue until the end of calendar year 2004, and catalyst activity will be evaluated for elemental mercury oxidation activity through routine (~monthly to bimonthly) evaluation trips. Intensive gas characterization efforts should occur in June and December 2004.

EXPERIMENTAL

The work described in this technical progress report was conducted using two different experimental apparatuses. One is an elemental mercury catalyst oxidation pilot unit (8000 acfm of flue gas treated) located at GRE's CCS Station in North Dakota. A second, nearly identical pilot unit is located at CPS' Spruce Plant. Each pilot unit has four separate compartments that allow four different catalysts to treat flue gas from downstream of the host plant's particulate control device and upstream of its FGD system. Details of the pilot unit design, construction, catalyst preparation and pilot unit operation have been discussed in previous quarterly technical progress reports^{1,2,3,4}. The activity of these catalysts is being determined by measuring the change in elemental mercury concentration across each catalyst, while ensuring that the total mercury concentrations do not change significantly across the catalyst. These measurements are primarily being conducted using a mercury semi-continuous emissions monitor (SCEM) developed with funding from EPRI. The analyzer has been described in a previous report⁵. Periodically, the analyzer results are being verified by conducting manual flue gas sampling efforts in parallel across each catalyst chamber by the Ontario Hydro method.

The second experimental apparatus is a bench-scale test unit that is used to evaluate the activity of candidate catalyst cores under simulated flue gas conditions. However, no bench-scale tests were conducted during the current quarter. The bench-scale catalyst oxidation test apparatus was previously described in quarterly technical progress reports^{3,4}.

RESULTS AND DISCUSSION

This section provides details of technical results for the current reporting period, October 1, 2003 through December 31, 2003. The technical results presented include a discussion of the data from the first pilot unit at GRE's CCS and from the second pilot unit at CPS' Spruce Plant.

Pilot Unit Operation at CCS

Background

As described in the previous quarterly reports, the first pilot unit was started up at CCS with the SCR and Pd #1 catalysts the first week of October 2002. The other two catalysts (SBA #5 and C #6) were not yet available, so testing began with only two of the four catalysts installed. Catalyst activity measurements were made using the EPRI mercury SCFM. October 2002 results showed over 90% oxidation of elemental mercury across the Pd#1 catalyst, as was expected based on previous laboratory and field tests with this material. The SCR catalyst results showed lower oxidation, in the range of 60 to 70% oxidation of elemental mercury across the catalyst. Throughout this report, the elemental mercury oxidation percentages across catalysts are reported based on the drop in elemental mercury concentration across the catalyst, and do not just reflect the total flue gas mercury oxidation percentage at the catalyst outlet.

In December 2002, measurement results showed a marked decrease in activity for both catalysts. The third catalyst, SBA #5, was also installed in December.

Testing in January determined that the catalyst surfaces were becoming plugged due to a buildup of fly ash, in spite of the catalyst being installed downstream of a high-efficiency ESP. This was confirmed by tracking pressure drop increases across the catalyst chambers and by physically inspecting the catalysts to observe and clean out the fly ash buildup.

It was decided that mechanical cleaning should be implemented on the pilot unit. Both air soot blowers and sonic horns were considered. It was decided that a sonic horn would be the easiest field retrofit and would offer a good probability of success. A small, 17-inch horn produced by Analytec Corporation of Pagosa Springs, Colorado appeared to be the best solution based on price, availability, and probability of success. During the last week of March 2003, an Analytec sonic horn was installed on the Pd #1 catalyst box to provide an occasional pulse of acoustic energy to the catalysts to dislodge accumulated particulate matter. The horn was installed on the top wall of the catalyst housing inlet transition, approximately 1.5 feet upstream of the first catalyst module. The horn sounds for 10 seconds every half hour.

At the time the sonic horn was installed, the catalyst housing was opened and the Pd #1 catalyst modules were cleaned. The plan was that, if effective, a horn would be subsequently installed on each of the other catalyst chambers. The pilot unit was placed back in service on March 27, and the horn was effective at controlling the pressure drop across the Pd #1 catalyst. A catalyst activity measurement trip was conducted the week of April 23. The Pd #1 results were confounded by apparent mercury adsorption seen across the catalyst (i.e., some of the drop in elemental mercury concentration across the Pd #1 could be due to adsorption rather than

oxidation) but otherwise showed high (~90%) elemental mercury oxidation across the catalyst. Based on the relatively high activity and low pressure drop values for Pd #1, the sonic horn retrofit was deemed a success and similar Analytec sonic horns were installed on the other three boxes by CCS plant personnel the first week of June 2003.

Catalyst Pressure Drop Results

With the horns in service, the pressure drops across three of the four catalysts have stayed low. The pressure drop values since June 5 are plotted in Figure 1. By the end of December, the C #6 pressure drop was about 0.4 in. H₂O, and the SCR catalyst (larger pitch and 1500 acfm flow rate) pressure drop was about 0.2 in. H₂O. The signal for the pressure drop across the Pd #1 catalyst became very noisy on about November 5, presumably due to water buildup in the tubing to the pressure drop transducer. The same thing happened with this transducer during cold weather operation the previous winter. However, the last “good” data on November 5 showed that the pressure drop across this catalyst remained low at 0.35 in. H₂O. The SBA #5 pressure drop continued to increase with time, to nearly 4 in. H₂O by the end of December, which is more than 10 times the initial pressure drop on June 5. This catalyst may have been adversely affected by a pilot unit trip in late May, which trapped wet, cool flue gas in contact with the fly ash coated catalysts. Alternately, it may be that there is a particle-to-particle attraction between the fly ash in the flue gas treated and the fly ash imbedded in the catalysts. A third possibility is that the sonic energy from the horn sounding in this compartment has damaged the honeycomb structure, thus causing a pressure drop increase due to blocked cells. This catalyst type is of lesser interest for future commercial applications, so regardless of the cause the pressure drop increase across this catalyst chamber is not of great concern.

Catalyst Activity Results

Two catalyst activity measurement trips were made to CCS during the quarter, one the week of October 6 and the second the week of December 15. The results of the catalyst activity measurements (by SCEM) are shown in Table 1. The inlet flue gas mercury concentrations were consistent between the two trips, with between 17 and 18 µg/Nm³ of total mercury and 27% mercury oxidation. As was seen in the July results presented in the previous technical progress report, all four catalysts appeared to have been adsorbing a small amount of mercury from the inlet flue gas, ranging from 9% to 16% apparent adsorption in October and between 4 and 19% in December. The activity of the C #6 and Pd #1 catalysts remained relatively high, with about 90% Hg⁰ oxidation across the C #6 catalyst and 75% Hg⁰ oxidation across the Pd #1. However, the measured activity for each was slightly lower than was last measured in July. The activity of the SBA #5 and SCR catalysts continues to be lower than the C #6 and Pd #1 catalysts, in the range of about 30% to 50% Hg⁰ oxidation.

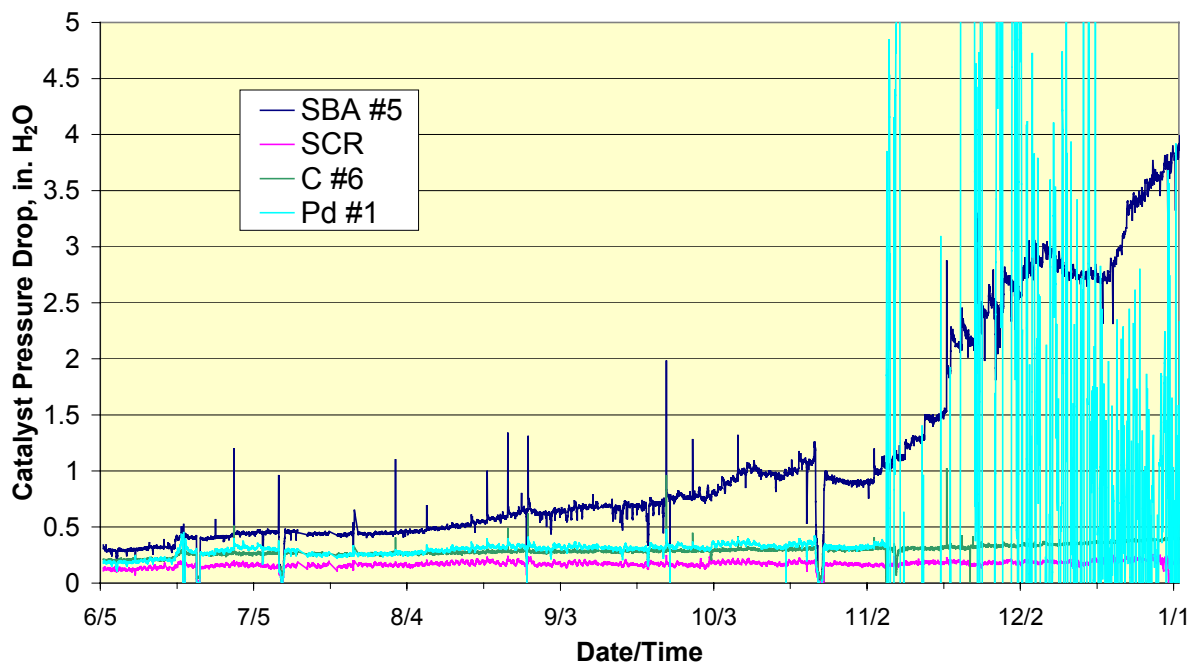


Figure 1. Pressure Drop Data for the Catalysts in Service at CCS through December

Table 1. Oxidation Catalyst Activity Results for CCS Pilot (measured by Hg SCEM)

Location	Total Hg ($\mu\text{g}/\text{Nm}^3$, corrected to 5% O_2)	Elemental Hg ($\mu\text{g}/\text{Nm}^3$, corrected to 5% O_2)	Apparent Total Hg Adsorption Across Catalyst, %	Apparent Hg^0 Oxidation Across Catalyst, %	Overall Hg Oxidation Percentage
Results from 10/8/03:					
Pilot Inlet	17.3	12.6	-	-	27
SBA #5 Outlet	15.47	7.20	11	43	53
SCR Outlet	15.81	9.08	9	28	43
C #6 Outlet	14.78	1.44	15	89	90
Pd #1 Outlet	14.57	3.30	16	74	77
Results from 10/9/03:					
Pilot Inlet	-	10.9	-	-	-
SBA #5 Outlet	-	5.74	-	47	-
SCR Outlet	-	7.61	-	30	-
C #6 Outlet	-	1.22	-	89	-
Pd #1 Outlet	-	2.90	-	73	-
Results from 12/16/03:					
Pilot Inlet	17.9	13.0	-	-	27
SBA #5 Outlet	17.1	9.09	4	30	47
SCR Outlet	17.4	8.58	3	34	51
C #6 Outlet	14.5	1.12	19	91	92
Pd #1 Outlet	16.2	3.19	10	76	80

The “clean catalyst” activity results for all four catalysts are plotted versus time in Figures 2 and 3. Some data points from late 2002 and early 2003, where the catalysts were obviously plugged with fly ash, have been edited from these plots. Activity results for the Pd #1 and C #6 catalysts are plotted in Figure 2 and activity results for SBA #5 and SCR catalysts in Figure 3.

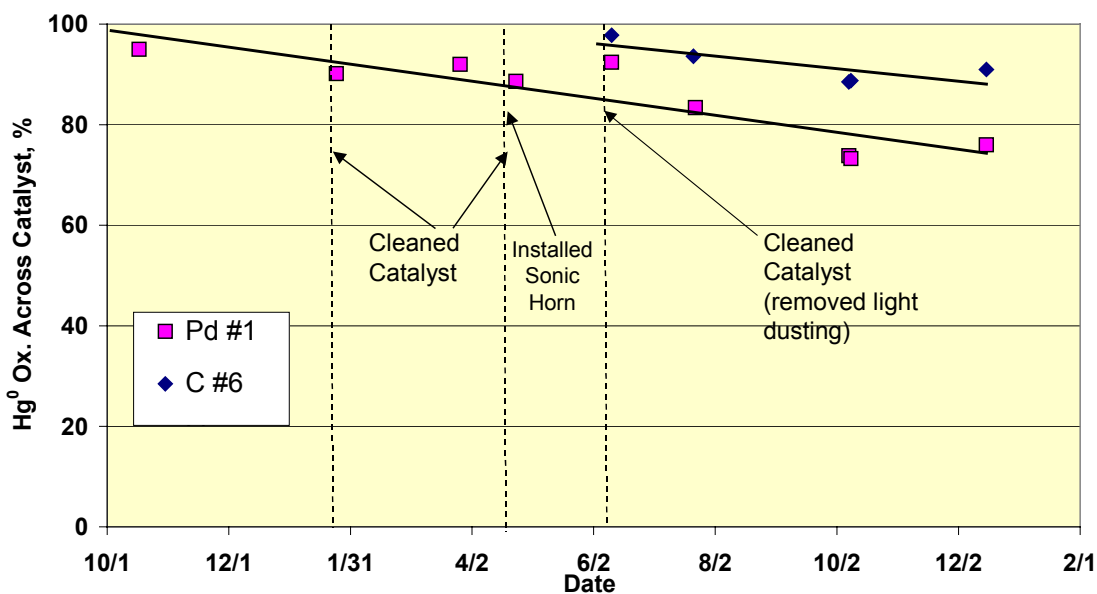


Figure 2. Activity for Hg^0 Oxidation versus Time for Pd #1 and C #6 Catalysts at CCS.

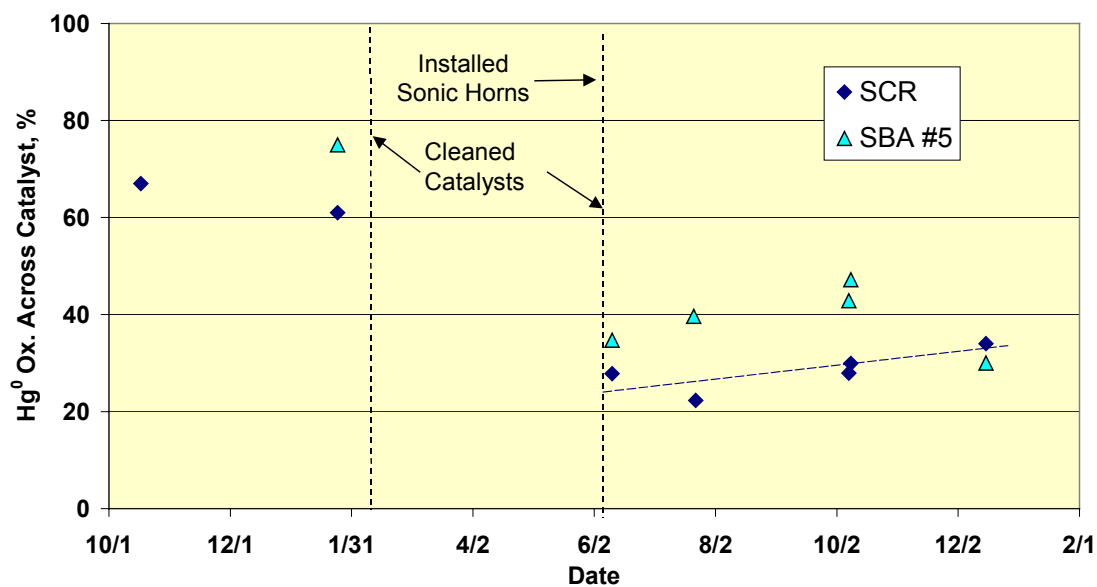


Figure 3. Activity for Hg^0 Oxidation versus Time for SCR and SBA #5 Catalysts at CCS.

The plots in Figure 2 show a general downward trend in the clean catalyst activity measurements for the two more active catalysts, although the December data show a small increase in performance over the October results. More time is needed and more measurements will be required to accurately quantify the change in activity versus time for the Pd #1 and C #6 catalysts.

For the SCR catalyst, the data in Figure 3 show a small improvement in Hg⁰ oxidation activity when comparing the October and December data to July results. For the SBA #5 catalyst, the October results were improved over July results, but a marked decrease in activity was seen in the December results. This drop in activity corresponds with significant pressure drop increases across that catalyst, so it is likely that the SBA #5 catalyst is either plugged with fly ash or has seen some structural damage due to the sonic horn energy. Again, more time is needed and more measurements will be required to accurately determine the long-term change in activity versus time for these catalysts.

Pilot Unit Operation at Spruce Plant

Catalyst Supply

In July 2003, the required catalyst dimensions for the pilot unit at Spruce Plant were determined based on laboratory and CCS activity results, and all four catalysts were ordered from their respective suppliers. Table 2 summarizes the catalyst dimensions. The Pd #1 and Au catalysts were delivered from Süd-Chemie Prototech in August and the SCR catalyst was delivered from Argillon in Germany on September 29. The C #6 catalyst took the longest time to procure because of the multiple process steps by several subcontractors that have to take place to produce this material in honeycomb catalyst form. It was delivered to Spruce Plant in late October.

Table 2. Catalyst Dimensions for Oxidation Catalyst Pilot Unit at Spruce Plant

Catalyst	Cells per in.² (cpsi)	Cross Section (in. x in.)	Length (in.)	Area Velocity (sft/hr)
Pd #1	64	30 x 30	9	49
Au	64	30 x 30	9	49
C #6	80*	36 x 36	9	27
SCR	46	35.4 x 35.4	29.5	13

*Die is sized at 64 cpsi, but shrinkage to this pitch occurs on drying

The host unit at Spruce Plant came off line for a fall outage the evening of September 26, and the outage continued until October 27. The plan was to install the two remaining catalysts (SCR and C #6) in the pilot unit and restart operation soon after the host unit came on line. The installation of the two catalysts and the restart was delayed until the week of November 10 to allow time for the host unit to come back into stable operation and for plant craft personnel to work through remaining outage/startup issues.

The pilot unit was restarted with all four catalysts installed the afternoon of November 13. A few remaining problems with the pilot unit were corrected at this time. A failed gauge-pressure transducer on one of the catalyst chambers was replaced, and the cause of zero differential indication values from the catalyst chamber pressure drop transducers was investigated and resolved.

Catalyst Pressure Drop Results

Figure 4 shows the pressure drop across the four catalyst chambers at Spruce from November 13 through the end of the quarter. The pressure drop values were erratic through the end of November due to flow rate controller tuning problems. After the controllers were retuned to provide more steady flue gas flow rates, the pressure drop across each of the four catalyst modules also became steady. The pressure drop values are all in the range of 0.2 to 0.3 in. H₂O. At this time, it does not appear that sonic horns will be required to prevent fly ash buildup, most likely because a high-efficiency reverse-gas fabric filter is used for particulate control at this site. The use of a baghouse most likely results in a lower dust loading in the pilot unit inlet flue gas, and a dust loading that has less residual electrostatic charge than would flue gas downstream of an ESP.

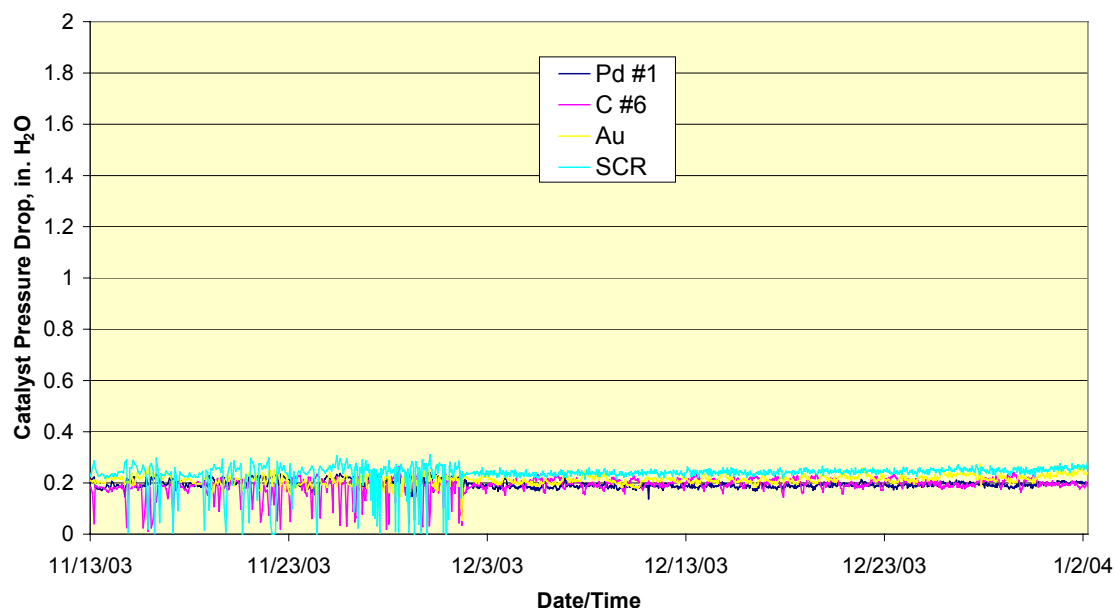


Figure 4. Pressure Drop Data for the Catalysts in Service at Spruce through December

Catalyst Activity Results

Host site flue gas and catalyst outlet mercury concentration data were collected the week of December 8. These results are still being reduced and evaluated, and will be presented along with the results of simultaneous Ontario Hydro measurements in the next Quarterly Technical Progress Report. In general, as did results presented in the previous technical progress report, the measurements at the pilot unit inlet showed high mercury oxidation percentages, typically over 75% oxidized, rather than the expected 20 to 30% oxidized mercury typical of PRB flue gases. This effect is still theorized to be an influence of the baghouse conditions at Spruce, which operates at a very low air-to-cloth ratio (less than 1.5 acfm/ft²), has aged bags (11 years old) and has a permanent dust cake that has possibly been influenced by pet coke co-firing (last fired December 2002). The baghouse is being rebagged in January 2004, so gas measurements in

February should quantify what, if any, bag aging has had on mercury oxidation across the baghouse.

Flue Gas Characterization Results

Also during the week of December 8, SCEM relative accuracy measurements were made using the Ontario Hydro method at the pilot unit inlet and the outlets of each of the four catalyst chambers. The Ontario Hydro method results are not yet available for reporting. They will be included in the next quarterly report, covering the time period January 1 through March 31, 2004.

Additional flue gas characterization measurements were made that week, including trace metals (EPA Method 29) and halogen species (Method 26a) at the pilot unit inlet and sulfuric acid concentration changes across the catalysts (Controlled Condensation System). Again, the results from all of these measurements are not yet available for reporting, and will be included in the next quarterly report.

Laboratory Evaluation of Candidate Catalysts

No laboratory evaluations were conducted during the current quarter.

CONCLUSION

In the initial six months of pilot unit operation at CCS, it became apparent that the potential for adverse effects from the ash remaining in the flue gas downstream of a high-efficiency ESP was underestimated at the beginning of the project. After two months of operation, the Pd #1 and SCR catalysts had seen a significant loss of activity for Hg^0 oxidation and a significant increase in pressure drop. Both of these effects were attributed to fly ash buildup within the catalyst chambers and within the flow channels of the catalyst honeycomb cells. Fortunately, the collected fly ash remained dry and free flowing, and was readily removed by blowing compressed air through the catalyst cells and vacuuming up loose fly ash.

Because of the observed ash accumulation on the catalysts at CCS, provisions had to be made to help keep catalyst surfaces cleaner. Sonic horns are commonly used to clean catalysts on line in utility SCR applications for NO_x control, and appear to be similarly effective in this application (lower dust loading but horizontal gas flow). A trial application of a sonic horn was installed on the Pd #1 catalyst chamber in late March, and was effective in limiting fly ash build up during two months of operation. Based on this success, similar sonic horns were installed on the other three chambers. In seven months of operation, the horns have been effective at limiting fly ash buildup in three of the four catalysts. Catalyst activity measurements in October and December indicate that the horns have also been effective in maintaining catalyst activity for three of the four catalyst materials. For the fourth catalyst, SBA #5, it appears that either the sonic energy from the horn has not been sufficient to prevent fly ash accumulation, or that the sonic energy has caused damage to the honeycomb structure. Either could explain the increased pressure drop and loss of activity across this catalyst.

After 15 months of operation, the Pd #1 catalyst has apparently seen some loss in activity for elemental mercury oxidation, from slightly greater than 90% to between 75 and 80%. The SCR catalyst has seen a more significant loss, dropping from 67% to less than 40% oxidation over the same period (as measured by SCEM). The SBA #5 catalyst has dropped from 75% oxidation to about 30% oxidation over a 13-month period (also based on SCEM results). However, all of these results are confounded by the fly ash buildup experienced prior to the sonic horn installations. The fly ash buildup could have had beneficial or negative effects on catalyst activity. If the catalysts can be deactivated by species in the flue gas, the honeycomb cells that were blocked by fly ash buildup may have been “protected” from deactivation by flue gas species. Conversely, the fly ash buildup could have directly affected catalyst activity in an adverse manner through physical blockage or chemical reactions at active sites. The C #6 has operated for seven months with a sonic horn in service to prevent fly ash buildup. The activity of this catalyst has decreased slightly, from greater than 95% to about 90%. More operating time is needed on all four catalysts to better quantify activity loss over time with the sonic horns in service to limit fly ash buildup.

None of the four catalysts appear to convert a significant amount of the flue gas SO_2 to SO_3 , nor do they appear to convert NO to NO_2 . This is a positive finding about this process, as significant oxidation of either species in the flue gas would be undesirable.

At the Spruce site, the baghouse upstream of the pilot unit has had two implications on the pilot testing. One is that it does not appear that sonic horns will be required to keep fly ash from accumulating within the catalyst cells. The other implication is that the baghouse oxidizes a high percentage of the elemental mercury in the air heater outlet flue gas, so the inlet gas to the pilot unit contains relatively low elemental mercury concentrations (typically 1 to 2 $\mu\text{g}/\text{Nm}^3$). This makes evaluation of catalyst performance difficult, as it is difficult to quantify flue gas elemental mercury concentrations below 1 $\mu\text{g}/\text{Nm}^3$. It is hoped that after the baghouse is rebagged in January 04, pilot unit inlet elemental mercury concentrations will increase to a higher concentration that will better support oxidation catalyst evaluation.

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